SEVIER LAKE WATERSHED, UTAH

LETTER

FROM

SECRETARY OF AGRICULTURE

TRANSMITTING

A SURVEY REPORT DATED MAY 1950, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, OF THE SEVIER LAKE WATERSHED IN UTAH, MADE UNDER THE PROVISIONS OF THE FLOOD CONTROL ACT APPROVED JUNE 22, 1936, AS AMENDED AND SUPPLEMENTED

MARCH 28, 1952.—Referred to the Committee on Public Works and ordered to be printed with illustrations

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UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1952

97320

LETTER OF TRANSMITTAL

DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, March 19, 1952.

The SPEAKER, HOUSE OF REPRESENTATIVES.

DEAR MR. SPEAKER: I am submitting herewith a survey report, dated May 1950, together with accompanying papers and illustrations, of the Sevier Lake watershed in Utah, made under the provisions of the Flood Control Act approved June 22, 1936, as amended and supplemented.

I recommend that the Secretary of Agriculture be authorized to carry out the program of runoff and water-flow retardation and soil-erosion prevention proposed in this report.

Enclosed are comments received from the representative of the Governor of Utah and the interested Federal agencies.

The Bureau of the Budget in its letter of March 6, 1952, advises that there is no objection to the submission of this report to the Congress. The Bureau further advises that it is in agreement with the objectives contemplated in the report of carrying out measures designed to retard floods and prevent soil erosion, and that this objective is particularly desirable from the point of view of coordination of upstream measures with the flood-control programs of the Corps of Engineers. A copy of the letter from the Bureau of the Budget is enclosed.

Sincerely,

CHARLES F. BRANNAN,
Secretary.

SEVIER LAKE WATERSHED, UTAH

LETTER FROM THE BUREAU OF THE BUDGET TO THE SECRETARY OF AGRICULTURE

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington 25, D. C., March 6, 1952.

The honorable the SECRETARY OF AGRICULTURE.

MY DEAR MR. SECRETARY: This will acknowledge receipt of Acting Budget Officer John Wells' letter of May 2, 1951, requesting advice as to the relationship to the President's program of the proposals contained in your Department's report of 1950, entitled "Survey Report, Sevier Lake Watershed, Utah."

Flood damage, exclusive of range productivity losses, has amounted to $273,100 annually during the past 40 years. It is estimated that future flood and sedimentation damages and range productivity losses will be $1,045,800 per year unless preventive measures are undertaken. The principal estimated annual future flood damages and losses are agricultural and range, recreation, and reservoir sedimentation. Floods also cause damages to public roads and railroads, while sediment damages occur to water supplies, drainage channels, and public health.

It is proposed to alleviate these damages and to realize extensive associated benefits by installing a number of interrelated and interdependent soil and water conservation and control measures or groups of measures, mostly vegetative in character, during a 10-year period. These measures, applied in proper combination with other soil and water conservation practices and measures, would constitute a basic system of soil and water conservation in accordance with needs and capabilities of the land in the Sevier Lake watershed. Educational assistance and technical services are also recommended as a part of the proposed program.

The estimated total cost of the recommended program, based on 1946 prices and an intermediate level of employment, is $14,850,000. The Federal Government would be expected to expend $13,336,000 of the total cost; and non-Federal public agencies and private interests would be required to pay $1,514,000, a part of which would be in labor, materials, equipment, and other assistance in lieu of cash payments. Operation and maintenance of the recommended works of improvement are estimated to cost $148,500 annually, of which $124,000 would be paid by the Federal Government and $24,600 or its equivalent would be borne by local interests.

It is estimated that the recommended watershed program, if installed as planned and maintained adequately, will yield average annual benefits evaluated at $1,181,000. Chief benefits are agricultural and range conservation, estimated at $689,200 annually, and

benefits to recreation, estimated at $217,800. The program involves mainly a vegetative approach, with certain complementary structural works.

The total average annual costs are estimated at $445,000. Since prices are expected to vary during the 10-year installation period, both benefits and costs were adjusted to anticipate future price levels by applying indexes provided by the Bureau of Agricultural Economics. Due to the effect of this adjustment or alternate evaluation, the average annual benefits are adjusted to $892,580 and the costs, on the same basis, to $448,900. This adjustment results in a revised benefit-cost ratio of 1.9 to 1.0 for the recommended program.

The report has been reviewed by the Governor of Utah and also by the several concerned Federal agencies, in accordance with policies and procedures for distribution and coordination of reports as adopted by the Federal Inter-Agency River Basin Committee. The views expressed are generally favorable to the proposed program, with suggestions limited to considerations that could be resolved cooperatively by the concerned agencies or local interests during the periods of planning and installing the watershed works of improvement.

The work envisioned in the report is constituted principally (76 percent) of land-treatment measures which are an intensification, acceleration, and adaptation of land-treatment activities already in progress under going programs of the Department of Agriculture. These include such programs as the conservation and use program, authorized by the Soil Conservation and Domestic Allotment Act, approved February 29, 1936, as amended; the Soil Conservation Service's program of assistance to districts and other cooperators, authorized by the act of April 27, 1935; and State and private forestry cooperation, pursuant to the act of August 25, 1950; sections 1 through 5 of the act of June 7, 1924, and acts supplementary thereto.

The Bureau of the Budget is in agreement with the objective contemplated in the report of accelerating land-treatment measures and installing structural measures designed to retard floods and prevent soil erosion. This objective is particularly desirable from the point of view of coordination of upstream measures with the flood-control programs of the Corps of Engineers.

The measures contemplated to implement the proposed program may be grouped into two broad categories—land treatment measures and structural measures. The Bureau of the Budget is of the opinion that installation of the structural measures (shown in table 3, p. 20 of the report as "structural works") should properly be authorized under the Flood Control Act, as amended and supplemented. The Bureau also believes that the land treatment measures set forth in the report, since they are largely an acceleration of existing programs of the Department of Agriculture, should be financed under appropriations other than that for the Flood Control Act. This would avoid confusion in the presentation of the Department's budgetary program, since many of the current land-treatment programs of the Department have the objective of runoff and water-flow retardation and the prevention of soil erosion. To the extent that the acceleration of land treatment measures under existing authorities is not possible, we urge that adequate authorities for such acceleration be sought through amendment of those basic authorities.

Your staff, on the other hand, believes that the Department cannot properly meet its responsibilities under the Flood Control Act unless the full program envisioned in the report is authorized under that act. Your representatives, however, agreed that appropriations for land treatment phases implementing the program recommended in the report, upon approval by the Congress generally on the basis as submitted, would be sought as additions to going program appropriations of the agencies carrying on the work. Funds for structural works or measures would still be requested under the appropriation "Flood control." The total obligations for land treatment and structural measures in each authorized flood-control project area could, of course, be shown in a summary table to be presented in the program and performance section of the annual budget document.

Subject to the above understanding as to the method of presenting the budget for flood-control programs, there would be no objection to the submission of the proposed Sevier Lake watershed flood-control survey report to the Congress. In the event the report or any modification thereof is approved by the Congress, submission of requests for appropriations must be justified in accordance with the policy set forth in the President's letter of July 21, 1950, which directed that all civil public works be considered with the objective, as far as practicable, of deferring, curtailing, or slowing down those projects which do not directly contribute to national defense or to civilian requirements essential to the changed international situation, or as may later be modified.

In submitting the Department's report to the Congress, it will be appreciated if you include a copy of this letter.

Sincerely yours,

ELMER B. STAATS,
Assistant Director.

LETTER FROM THE CHIEF OF ENGINEERS TO THE SECRETARY OF AGRICULTURE

DEPARTMENT OF THE ARMY,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington 25, D. C., May 11, 1951.

The honorable the SECRETARY OF AGRICULTURE.

DEAR MR. SECRETARY: Reference is made to my letter of January 16, 1951, furnishing comments on your survey report on Sevier Lake watershed, Utah. Subsequent to the transmission of these comments discussions were held by our staffs on the report. As a result of these discussions, I am pleased to inform you that this letter supersedes my letter of January 16.

The report recommends that the Federal Government undertake an extensive watershed treatment for retarding erosion, sedimentation, and flood runoff involving principally rehabilitation of vegetative cover by improved range management and fire control, artificial reseeding, removal of competitive types of cover, and limitation of grazing by game and livestock; contour furrowing and trenching; and structural works, located mainly in the foothills, comprising check dams, gully plugs, debris basins, spreading works, improvement of canals and natural channels, construction of floodways, road improve-

ments for erosion control along 983 miles of road, and construction of 720 miles of truck trails and about 1,800 miles of fences. The total first cost of the program, based on 1946 prices, is estimated at $14,850,000 including $1,514,000 non-Federal costs. The total annual installation and maintenance costs have been estimated at $445,000. The average annual benefit from the program is estimated at $1,181,000, of which $142,800, or 12 percent, would be flood control. On the basis of economic analysis used in the report, the program is shown to have a favorable economic ratio of 2.4.

I have no specific comments to make regarding the watershed management program, which constitutes the larger part of your recommended plan of improvement. However, the flood-control structures and features recommended in your report are of concern to the Corps of Engineers because of its legislative responsibility for control of floods, and I have certain comments regarding them.

The report recommends construction of 34 new debris basins with appurtenant works and spreading areas, strengthening of some of the 19 existing debris dams, and construction of 11 floodwater diversions all at an estimated cost of $1,121,000. Three of the new debris basins are designed as masonry or concrete arches, eleven are designed as earth-fill dams with chute spillways, one with spillway at grade on the center of the debris cone, and the remainder with center spillways of masonry or concrete. Foundation and related pertinent data showing the adequacy of the three arch dams and of the spillways of the other proposed dams are not given. While the report does not present sufficient data to permit a thorough check of the design, the cost estimates, or the effects and benefits of these reservoirs, our experience indicates that costs of actual construction to provide structures with a reasonable degree of safety and utility will be considerably higher than estimated in the report. More detailed engineering studies will be required to determine accurate costs, exact locations and probable effects upon flood flows. These engineering studies would of course be necessary before construction is undertaken. The necessity for such studies and their possible effects upon the economics of the plan, and for careful coordination of flood control plans, should be recognized.

The opportunity to review your report is appreciated.

Sincerely yours,

LEWIS A. PICK,
Major General,
Chief of Engineers.

LETTER FROM THE ASSISTANT SECRETARY OF THE INTERIOR TO THE SECRETARY OF AGRICULTURE

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington 25, D. C., December 22, 1950.

Hon. CHARLES F. BRANNAN,
Secretary of Agriculture, Washington 25, D. C.

MY DEAR MR. SECRETARY: In accordance with Federal Inter-Agency River Basin Committee procedures, Assistant Secretary Hutchison transmitted by letter dated June 5, 1950, for the information and comments of the Department, copies of the Department of

Agriculture's Survey Report on the Sevier Lake watershed in southern Utah.

The report recommends a remedial watershed program to reduce runoff and erosion, stabilize the soil, and benefit and conserve water supplies on the Sevier Lake watershed in southwestern Utah. It is estimated that the recommended program will cost approximately $14,850,000 for installation and about $148,500 annually thereafter for maintenance. Of this amount, the Federal Government's share is about $13,336,000, including $783,000 for land purchase, during the installation period of 10 years, with an annual maintenance cost thereafter of about $124,000. Installation costs of private and other public interests are about $1,514,000, with an annual maintenance cost thereafter of $24,600. The ratio of benefits to costs is given as 2.4 :1.

In the review of the report at regional level, field representatives of the Bureau of Reclamation and the Fish and Wildlife Service of this Department have commented on the report. Opportunity for such review in accordance with the procedures of the Federal Inter-Agency River Basin Committee is appreciated. During review of the report here, our Departments held an informal technical discussion of this report and the general watershed programs of the Department of Agriculture. This resulted in a better understanding of these broad watershed programs, the purpose of this and similar reports, and the procedures followed in their preparation, thereby eliminating need for comment on many technical points. Other meetings for discussing their problems of mutual interest will be welcomed in the future.

Many problems are involved in evaluating the future effects of land management programs on various aspects of water flow. The science of hydrology has not yet advanced to a point where completely satisfactory methods have been developed for making such evaluations. The report, however, presents a plan that is as logically based as is consistent with the present state of our knowledge.

In the Sevier, as in many western watersheds, more basic data would greatly aid in better evaluating the watershed treatment program. Modern topographic and geologic maps are presently available for less than one-fourth of the area. Only the Sevier River and a few other important streams are currently being gaged to give an adequate record of stream discharge, and sediment loads are not measured anywhere in the basin, while ground-water conditions have been studied in detail in only a few small areas. More information could profitably be obtained to determine better the net effects of the program. Evaluation and study should include range conservation, by far the most important single benefit, through joint studies embracing hydrology, ecology, and forestry.

The information thus developed would permit adaptations and modifications of techniques for accomplishing objectives and provide desirable information on the physical results of land treatment.

The Department recognizes that detailed engineering information to establish specifically installation criteria will be essential prior to carrying out the work recommended in the proposed program. The report would be enhanced, however, by the addition of a description of the sampling techniques employed in planning the watershed pro-

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grams, including typical designs and cost estimates for the types of structures proposed.

The report stresses the effect of the depletion of plant cover and the deterioration of soil on the serious flood and sediment damages. Analysis of the present damages and the future benefits attributed to the proposed program are in a large measure not directly related to erosion and sedimentation since about three quarters of the estimated future benefits of the program accrue from recreation and range conservation.

In the computation of the benefits-costs ratio for the proposed Sevier Lake project, we feel that the downward adjustment which has been made for the construction cost, is greater than might reasonably be expected at this time.

There are significant areas of public domain lands in this watershed which make this conservation and protection program of vital interest to the Bureau of Land Management of this Department. In general, the recommended program provides for similar improvements and land treatment as are employed in the soil and moisture conservation work of this Department. However, there is a real need for coordination with the management program of the Bureau of Land Management. The range improvement aspects of the recommended program hinge upon the reestablishment of good grass cover through reseeding on the valley lands, approximately half of which are public domain. The plan contemplates that the increased forage production thus provided will absorb the curtailed grazing use required in the rehabilitation of national forest range. No provision is made, however, for the replacement of grazing uses now obligated on the public domain lands which are to be reseeded.

In addition to the watershed development program, the report recommends measures for the management of livestock and big game. The Department feels that the over-all effect of the development on big game has not been adequately covered. There are opportunities for enhancing benefits and for preventing losses to big game which can feasibly be included without sacrificing the primary purposes of the program to any significant degree. The Fish and Wildlife Service of this Department and the Utah State Game and Fish Department desire opportunity to make detailed studies and recommendations in order that authorization of the program will allow reasonable modifications in the interest of the fish and wildlife resources.

Generally, it can be stated that any elimination of flood hazards or sedimentation damage to structures which can be accomplished by the Department of Agriculture at a reasonable cost and can be coordinated with the work of this Department will be of benefit to us. We recommend that the programs of the Bureau of Reclamation, the Bureau of Land Management, and the Forest Service be coordinated in the areas where potential projects of both agencies are found to insure orderly and systematic developments and operations and to prevent possible duplication or misplacement of structures. To the extent that your Department might wish to cooperate, the Geological Survey, the Bureau of Land Management, and the Bureau of Reclamation of this Department are willing to consider a research program

to study in detail the hydrologic effects of the program on different kinds of range land in order that in the future data will be available to evaluate better this important item of range conservation.

Thank you for the opportunity of reviewing this report.

Sincerely yours,

WILLIAM E. WARNE,
Assistant Secretary of the Interior.

LETTER FROM THE DIRECTOR OF THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE TO THE SECRETARY OF AGRICULTURE

UNITED STATES DEPARTMENT OF COMMERCE,
BUREAU OF FOREIGN AND DOMESTIC COMMERCE,
Washington 25, D. C., November 8, 1950.

Hon. K. T. HUTCHINSON,
Assistant Secretary of Agriculture,
Washington, D. C.

DEAR MR. SECRETARY: Thank you for the opportunity to review the Department of Agriculture's report on the Sevier Lake watershed area, Utah. We find we have no specific comments to make on this program, but appreciate your courtesy in making it available to us.

Sincerely,

H. B. MCCOY, *Director.*

LETTER FROM THE ASSISTANT SURGEON GENERAL TO THE ASSISTANT SECRETARY OF AGRICULTURE

FEDERAL SECURITY AGENCY,
PUBLIC HEALTH SERVICE,
Washington 25, D. C., October 26, 1950.

Mr. K. T. HUTCHINSON,
Assistant Secretary, Department of Agriculture,
Office of the Secretary, Washington 25, D. C.

DEAR MR. HUTCHINSON: The report entitled "Sevier Lake Watershed, Utah, 1950 (Report of Appendices 1, 2, 3, and 4)" furnished by your Department has been reviewed by us according to the policies and procedures of the Federal Inter-Agency River Basin Committee.

There was not time to prepare a memorandum. In the future the practice of submitting written reviews will be adhered to, however. We are hereby giving clearance to the report and a copy of this letter is being sent to the Secretary of the Federal Inter-Agency River Basin Committee for his information.

Sincerely yours,

M. D. HOLLIS,
Assistant Surgeon General,
Associate Chief, Bureau of State Services.

LETTER FROM THE ACTING CHAIRMAN OF THE FEDERAL POWER COMMISSION TO THE SECRETARY OF AGRICULTURE

FEDERAL POWER COMMISSION,
Washington 25, D. C., September 15, 1950.

Subject: Sevier Lake watershed, Utah.

Hon. CHARLES F. BRANNAN,
Secretary of Agriculture,
Washington 25, D. C.

DEAR MR. SECRETARY: The comments herein with respect to your Department's survey report on the Sevier Lake watershed in southern Utah, dated 1950, are transmitted in response to the Assistant Secretary's letter of June 5, 1950. The transmittal of these comments is in accordance with established procedures of the Federal Inter-Agency River Basin Committee.

The survey report recommends a program for flood-control improvements in the Sevier Lake Basin, consisting of various land-treatment measures, channel improvements, small check dams, and larger debris dams and other measures to reduce flood runoff and soil erosion. It is expected that the measures recommended will, in most instances, reduce the peak flows from summer floods below flood proportion. On the average, it is estimated that flood peaks will be reduced by about 45 percent, and sedimentation rates by about 55 percent. About 60 percent reduction is expected in future flood and sediment damages. The report also states that the productivity of the range will be restored, recreational values will be enhanced, irrigation will become possible on certain dry-farmed land, and the ground-water supplies will be augmented. It is expected that there will be little reduction in the water supply; and that the quality of runoff water will be improved. The total installation cost of the entire recommended program is $14,850,000. Of this cost $13,336,000 is the Federal share, and $1,514,000 is the direct cost to the local people. The total annual benefits have been estimated to be $1,181,000, and the total annual costs to be about $445,000.

The Commission staff has reviewed the report of your Department primarily with a view to determining whether the plan of improvement offers any possibilities for hydroelectric power development, or would affect existing or potential power developments. There are 17 small existing hydroelectric developments in the Sevier Lake watershed, having an aggregate installed capacity of 6,185 kilowatts. Two of the largest developments are the Upper Beaver and the Lower Beaver plants of the Telluride Power Co. with an aggregate installation of 3,000 kilowatts. The possibilities of developing additional hydroelectric power using water originating in the basin are limited owing to the low average runoff and the intermittent character of the stream flow. There may be opportunity however, for developing significant amounts of power in connection with possible future transbasin diversions such as those involved in the proposed central Utah project of the Bureau of Reclamation.

The flood-control program presented in the survey report probably will have but small effect on the power potentialities in the Sevier Lake watershed. It may be expected that some water will be lost transpiration, with the large-scale planting and replanting envisioned in the report. However, with a greater proportion of the rainfall

percolating into ground water, to run off later at a slower rate, the probable net effect on existing and future hydroelectric power may be beneficial. Without doubt, the revegetation of eroded areas, the correction of sloughing channel banks, and the construction of debris basins will be beneficial to the small existing power plants, and to any future hydroelectric developments.

The Commission appreciates the opportunity of reviewing and commenting on the report of your Department.

Sincerely yours,

THOMAS C. BUCHANAN,
Acting Chairman.

LETTER FROM THE STATE ENGINEER OF UTAH TO THE ASSISTANT SECRETARY OF AGRICULTURE

THE STATE OF UTAH,
OFFICE OF STATE ENGINEER,
Salt Lake City, Utah, July 13, 1950.

Mr. K. T. HUTCHINSON,
Assistant Secretary, Department of Agriculture,
Washington, D. C.

DEAR MR. HUTCHINSON: Gov. J. Bracken Lee has referred to me your letter of June 5, 1950, relative to matter of comments on the Department of Agriculture's survey report on the Sevier Lake watershed in southern Utah. The Governor has suggested that if there be any comments on the report that you will be advised from this office.

My comments are as follows:

It is proposed under this program, which is in compliance with the Flood Control Act of June 22, 1936 (49 Stat. 1570) as supplemented by the Act of June 28, 1938 (52 Stat. 1215), Seventy-fifth Congress which is quoted as follows:

> The Secretary of Agriculture is authorized and directed to cause preliminary examinations and surveys to be made for runoff and flow retardation and soil-erosion prevention on watersheds of * * * streams draining into Great Salt Lake, the Great Basin, Utah and Nevada * * * of which the Sevier Lake and its tributary streams are a part.

to restore wasted areas to their virgin condition.

This is a remedial watershed program. The watershed has been abused and denuded by overgrazing, by too large herds of deer and by means of unwise use of the resources of the area. Primary emphasis in the program will be placed on restoration of vegetative cover and its improvement by reseeding with grasses primarily for the purpose of restoring these areas to profitable use for grazing. Flood control and silt erosion will be sought to be controlled by channel improvements, the building of debris basins, stabilization of road banks. Fenced areas which will be reseeded, it is hoped, will hold back the early waters and the other methods of flood control will assist therein. This seeding program is expected to take about 10 years for completion and possibly up to 50 years before the depleted areas are restored to their virgin condition.

Before the program in the uplands can be undertaken it is proposed to reseed some 316,000 acres of valley lands to be used for grazing purposes. This is in order not to upset the local economy. Numerous

water developments for stock watering purposes will be undertaken in order to control grazing in the State. It is estimated that the program will cost $14,850,000, of which $13,336,000 will be Federal money and $1,514,000 from State and private funds. It is thought it will cost $124,000 Federal and $24,600 per year State and private for maintenance purposes during the period that the area is recovering from its bad "sick spell."

There is no doubt that there is virtue in the work if the results turn out as anticipated; however, it is noted from studying the report that no tree or shrubbery planting is anticipated except for the planting of Russian olives, willows, and such long-rooted shrubbery along the water channels.

Recommendations: In making comment on this program I would recommend that a more intensive reforestation program be contemplated, particularly on the heads of the various streams. I also recommend that the valley reseeding which will be done primarily on private lands and lands under the Bureau of Land Management, be made permanent, thus relieving the necessity of future grazing on the high elevations which has been the cause of the area's deterioration in the past.

It is to be noted that the program anticipates absolute control by various Federal agencies of the area in question. The advisability of turning the individual rights of inhabitants of the areas over to these agencies is questionable. These agencies are the Forest Service, the Bureau of Land Management, the Soil Conservation Service, and other interested bureaus.

The report has not been confirmed by Congress and does not set up any appropriation of moneys. A separate appropriation bill must be passed by Congress before the work can be activated.

Save for the above-stated comments the program is commendable.

Sincerely,

HAROLD A. LINKE,
State Engineer.

UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY REPORT
PROGRAM OF RUNOFF AND WATERFLOW RETARDATION AND SOIL EROSION PREVENTION
SEVIER LAKE WATERSHED, UTAH

Pursuant to the Act approved June 22, 1936 (49 Stat. 1570), as amended and supplemented.

CONTENTS

LIST OF APPENDIXES MADE IN CONNECTION WITH THE REPORT

(These appendixes are not printed in this document)

Appendix:

No. 1 Watershed management.
No. 2 Watershed engineering.
No. 3 Hydrology.
No. 4 Watershed appraisal and comments by other agencies.

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SEVIER LAKE WATERSHED

SUMMARY AND RECOMMENDATIONS

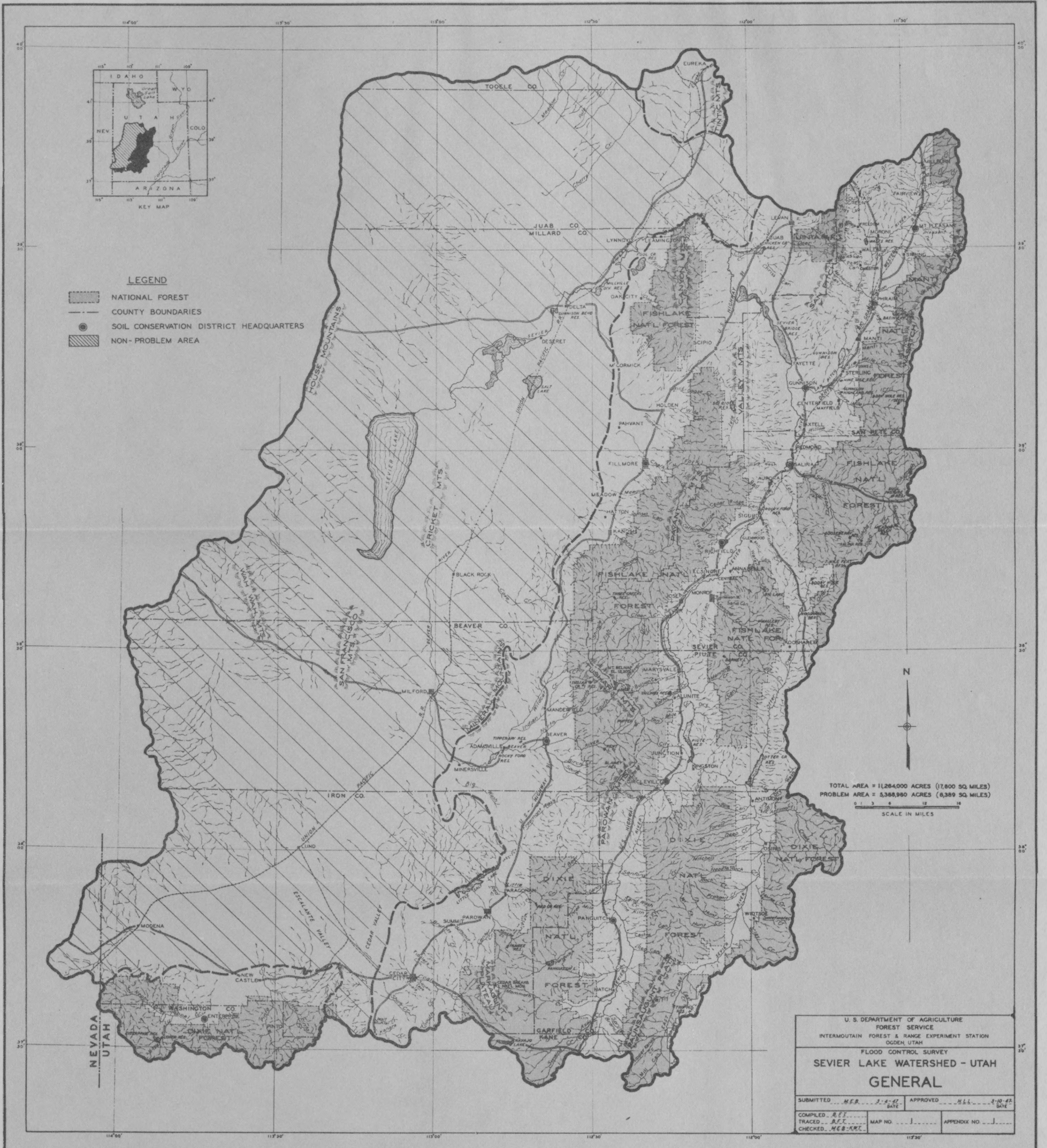
An investigation has been made of the Sevier Lake watershed in southwestern Utah. This revealed that depletion of plant cover and deterioration of the soil mantle have resulted in serious flood and sediment damages especially in that part of the watershed drained by the Sevier River and lesser independent tributaries. With continued depletion of the protective plant cover and further erosion and gullying on mountain and foothill lands, the flood problem will become more critical and damages will mount.

A remedial watershed program is therefore recommended to reduce high rates of runoff and erosion and thus effect a material reduction in property damage and other losses in the basin. It is to stabilize the soil and benefit the water resource. It will also perpetuate the local economy which is largely dependent upon the public lands involved. Primary emphasis in the program will be placed upon the restoration of vegetative cover and its improvement. This will be accomplished through such means as seeding and planting, contour terracing and similar aids, check dams and other erosion control structures, protection of vegetation from fire and other abuses, channel stabilization, improved management of livestock and big game; and reduction in range use. The protection afforded by the vegetal phases will be furthered by the use of debris basins; the stabilization of road banks, and channel improvements. To prevent serious disturbance to the local economy while the initial phases of the program get under way, reseeding of certain valley lands will be needed. To achieve full and continuing benefits from the program, certain critical mountain lands should be placed in public ownership.

The recommended program will cost approximately $14,850,000 for installation and about $148,500 annually thereafter for maintenance. Of this amount, the Federal Government's share is about $13,336,000, including $783,000 for land purchase, during the installation period of 10 years, with an annual maintenance cost thereafter of about $124,000. Installation costs of private and other public interests is about $1,514,000, with an annual maintenance cost thereafter of $24,600. The ratio of benefits to costs is 2.6:1.

It is assumed that the current programs of Federal agencies in the watershed will continue at their present rate during the installation period. The program herein recommended therefore includes only the intensification, acceleration, and adaptation of pertinent current activities plus additional measures not now regularly undertaken.

It is anticipated that the recommended measures will be installed on non-Federal lands under cooperative arrangements with individuals, with State and local governments, or other agencies acceptable to the Secretary of Agriculture.


KEY MAP
IDAHO
WYO
UTAH
NEV
COLO
ARIZONA
LEGEND
NATIONAL FOREST
COUNTY BOUNDARIES
SOIL CONSERVATION DISTRICT HEADQUARTERS
NON-PROBLEM AREA
TOOELE CO
EUREKA
JUAB CO.
MILLARD CO.
LYNNDYL
LEAMINGTON
NEPHI
MT. PLEASANT
FAIRVIEW
MORONI
MANTI
FISHLAKE NAT'L FOREST
OAK CITY
DELTA
DESERET
SCIPIO
McCORMICK
HOLDEN
PAHVANT
FILLMORE
MEADOW
KANOSH
HOUSE MOUNTAINS
SEVIER LAKE
CRICKET MTS
BLACK ROCK
BEAVER CO.
SAN FRANCISCO MTS
MILFORD
MINERSVILLE
ADAMSVILLE
BEAVER
IRON CO.
LUND
MODENA
NEW CASTLE
ESCALANTE VALLEY
CEDAR VALLEY
SUMMIT
PAROWAN
PARAGONAH
PANGUITCH
DIXIE NAT'L FOREST
PAROWAN MTS
GARFIELD CO.
KANE CO.
WASHINGTON CO.
ENTERPRISE
DIXIE NAT'L FOREST
NEVADA
UTAH
SAN PETE CO.
SALINA
FISHLAKE NAT'L FOREST
SIGURD
RICHFIELD
ELSINORE
MONROE
SEVIER CO.
PIUTE CO.
MARYSVALE
JUNCTION
CIRCLEVILLE
KINGSTON
ANTIMONY
GUNNISON
CENTERFIELD
MAYFIELD
SALINA
FAYETTE
STERLING
N
TOTAL AREA = 11,264,000 ACRES (17,600 SQ. MILES)
PROBLEM AREA = 5,368,960 ACRES (8,389 SQ. MILES)
SCALE IN MILES
U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
INTERMOUTAIN FOREST & RANGE EXPERIMENT STATION
OGDEN, UTAH
FLOOD CONTROL SURVEY
SEVIER LAKE WATERSHED - UTAH
GENERAL
SUBMITTED M.E.B. 3-4-47 DATE
APPROVED H.L.L. 3-10-47 DATE
COMPILED B.F.T.
TRACED B.F.T.
CHECKED M.E.B.-K.W.T.
MAP NO. 1
APPENDIX NO. 1

SEVIER LAKE WATERSHED, UTAH

INTRODUCTION

Authority.—This report has been prepared in compliance with the Flood Control Act of June 22, 1936 (49 Stat. 1570), as amended and supplemented.

DESCRIPTION OF THE WATERSHED

The Sevier Lake watershed covers some 17,600 square miles of moutain and valley lands in southwestern Utah and southeastern Nevada (map 1). The desertlike western half of the basin was excluded from consideration at this time because of the rarity of flood occurrence and low damages. The remaining 8,389 square miles, largely in the drainage of the Sevier River and independent streams on the western slopes of Markagunt Plateau, Parowan, Tushar, and Pavant Mountains, support the bulk of the population and produce most of the wealth of the watershed. Here recurring damaging floods and sedimentation occur. This document deals with this portion of the drainage.

The Sevier River drains the high plateaus of southern Utah where elevations reach to above 10,000 feet. The river rises in the southern part of the area and flows northward for some 170 miles until it swings westerly for about 80 miles to end in saline Sevier Lake at an elevation of 4,470 feet. The major tributaries are the San Pitch River, Salina Creek, East Fork, and Otter Creek.

The western slopes of the Markagunt Plateau, Parowan, Tushar, and Pavant Mountains are drained by many short independent streams which disappear in the desert before reaching Sevier Lake. All of these streams rise at high elevations in the mountains which are the source of the water supporting the numerous communities along the base of the mountains.

The valley floors generally are low gradient with slopes of less than 5 percent. The alluvial fans at the base of the mountains are steeper with slopes up to 20 percent, and steep headwater slopes range from 30 to 60 percent with some vertical cliffs and escarpments. In the space of a few miles the plateaus may rise from 5,000 to 12,000 feet.

Soils and erosion.—The majority of the soils found in the mountain-valley area are residual in origin and are more or less modified by colluvial effects. The soils are relatively deep and strongly reflect the influence of their parent materials. Soils developed from igneous and metamorphic rocks, which make up 41 percent of the area, have higher infiltration rates and are more resistant to accelerated erosion than those soils developed from sedimentary materials. Of the soils developed from sedimentary rocks, which comprise approximately 32 percent of the area, those from the sandstones have lower infiltration rates and are more erosive than the limestone soils. The soils of the

remaining 27 percent of the area have developed from the alluvium found in the valleys and in general have high infiltration rates.

Accelerated erosion is widespread on the watershed slopes, particularly on the headwater areas and in many of the canyon bottoms. Severe accelerated erosion occurs on approximately 29 percent of the mountain area, moderate accelerated erosion on 47 percent, and slight accelerated erosion on 15 percent. Naturally barren claybeds and rock outcrop total 9 percent of the mountain area.

Plant cover.—Early explorers relate that the main valley of the Sevier and the neighboring adjoining slopes was excellent grazing country. In some of his early (1843) explorations Captain Gunnison said of the Sevier basin, "We had now entered a region of great pastoral promise, abounding with fine streams, a rich bunchgrass, soil that would produce wheat and indigenous flax growing as if it had been sown." The same thing was true of the valleys tributary to the upper and middle reaches of the Sevier River. Beckwith, in one of Captain Gunnison's journals (1843), describes Salt (Salina) Creek as, "Here, although the vegetation is withered by frost, it covers the whole face of the country and gives it a very cheerful aspect * * * our animals for the first time for days feast on the abundant grass." And later he says, "The hills and valleys in every direction sustain the character of those of the last 2 days in beauty and luxuriance of grass and absence of large trees."

Today the uncultivated lower valley lands and foothills of the watershed generally support open stands of sagebrush, pinion pine, and juniper with an intermingling of sparse grasses and herbs. On the foothills and lower mountain slopes are denser stands of sagebrush, oakbrush, and other mountain shrubs, with an understory of grass and herbs. On the mountain slopes there are open to dense stands of coniferous timber, dense stands of aspen and brush, with some grasses. On many areas, the grasslands and meadows accessible to livestock have been seriously depleted.

Climate.—In the lower valleys the dry climate produces sparse vegetation, while in the high mountains a more humid climate prevails supporting a more abundant forage. Average annual precipitation ranges from about 8 inches in the western desert to over 30 inches in the mountains. Extremes of temperature are 115° F. in summer and −38° F. in winter. The growing season in the principal agricultural valleys averages about 150 days, but in the higher mountain valleys this is reduced to 80 days or less. During the winter months precipitation occurs as snow, averaging about 6 feet deep in the high mountains. Most of the water yield comes in the spring from snow melt that for the most part enters the soil mantle and appears in the channels as seepage flow. Spring and fall precipitation occurs as low intensity rainfall. Summer storms are frequently "local cloudbursts" of short duration often covering only 20 square miles or less. These storms produce as much as 2.78 inches of rainfall in 2 hours and rates up to 4 inches per hour for shorter periods have been recorded.

Economy.—Mormon pioneers began settlement of the Sevier Lake basin in 1849. Settlements were located on the gently sloping alluvial fans where favorable conditions of soil and water were found. Present population (1940) is approximately 53,000 people, about two-thirds

reside in urban centers of from 100 to 5,000 persons. In 1940 the gross income from agriculture, mining, and manufacturing was nearly $13,000,000, of which about 80 percent was derived from livestock and farm products. In the same year gross sales from retail, wholesale, and service enterprises amounted to almost $18,000,000. Tangible property had an estimated value in excess of $227,000,000.

Big game hunting is important as a source of income to the area as well as a popular sport. In recent years it has contributed materially to the economy of the people. Each fall there is an influx of several thousands of hunters from other parts of the State as well as from other States. Information published by the Utah State Fish and Game Commission and Forest Service records show some 13,500 deer and 150 elk were killed in 1946 by hunters who spent an estimated $629,000 in the watershed.

There are over 3,600 farms and ranches in the area. About 321,900 acres are devoted to tilled crops of which 227,800 acres are irrigated. Over $12,000,000 have been invested in irrigation works to date. Should proposed transmountain diversions of Colorado River water be made into the basin, much additional land can be irrigated. The nonirrigated croplands are relatively small in area and restricted to localities favored by sufficient rainfall to render small grain farming successful on a summer fallow basis.

Range livestock production is a dominant element of the general agricultural economy. Fifty-five percent of all farms and ranches are involved in some form of this activity. Even the few farms without livestock, produce pasture or feeds for winter maintenance or fattening purposes. Approximately one-fourth of the estimated tangible property values of the basin is made up of the grazing value of range lands.

In 1946 the area supported an estimated 64,000 range cattle and 202,000 range sheep. Range use by cattle and sheep on the national forests is only about 50 percent of the peak which was reached in 1917. On other grazing lands, use by sheep has increased by about 30 percent and use by cattle has nearly trebled. Some 65,000 deer and 900 elk utilize forage in the watershed. The present (1946) grazing use by all classes of animals is equivalent to about 1,100,000 animal-unit months. Of this total about 41 percent is accounted for by cattle, 39 percent by sheep, and 20 percent by big game.

Livestock are wintered in the lower valleys, and as soon as growth begins in the spring, they are moved onto the foothill ranges. As the season advances they are moved to higher elevations. By midsummer they are occupying the high summits. The use of mountain range lands for summer grazing by livestock when forage in the hot valleys is limited, is an important part of grazing practice.

Of the 5,370,000 acres surveyed, about 4,800,000 acres contribute materially to flood and sediment problems. Some 3,625,000 acres or 76 percent of the flood and sediment production area is in Federal ownership. This includes 2,265,000 acres of mountain and foothill land in national forests, and 1,325,000 acres of nonarable valley and desert land in grazing districts and public domain. Some 35,000 acres are in withdrawals as potential reservoir sites. About 244,000 acres or 5 percent is in State and county ownership, and 933,000 acres or 19 percent, mostly mountain and foothill land, is privately owned.

Land ownership, 1946, of flood and sediment production areas

Classes of ownership:	Acres
Federal Government	3, 624, 320
National forests	2, 264, 960
Grazing districts	1, 324, 160
Government withdrawals	35, 200
State and county	243, 840
Private	933, 335
Total	4, 801, 495

The area is served well by highways and to a lesser extent by railroads. A branch of the Denver and Rio Grande Western traverses the Sampete and Sevier Valleys. The Union Pacific Railroad line from Ogden to Los Angeles passes through the watershed. Two national north-south highways extend through the main valleys connecting the principal towns. Both highways and railroads parallel main streams and cross many tributary streams within their flood plains. Many other main roads traverse canyon bottoms subject to local floods.

FLOOD PROBLEMS

Past floods.—More than 300 summer floods have been reported by 28 towns and 11 agricultural areas in the Sevier Lake Basin. All have been a hazard to life and property. Some have been confined to small side canyons causing minor damage while others have been torrents of water carrying heavy loads of mud and rocks which damaged urban and highly developed agricultural areas. A single flood has caused up to $200,000 damage. During the past 40 years the recorded flood damage exclusive of range productivity losses has amounted to about $273,100 annually.

Deterioration of headwater areas since settlement has resulted in an increase in the number of floods as shown in table 1.

TABLE 1.—*Summer floods on tributaries of Sevier River, 1852–1946*

Years	Number of floods		Years	Number of floods	
	Total	Severe		Total	Severe
1852 to 1866	5	5	1917 to 1926	29	14
1867 to 1876	5	3	1927 to 1936	97	35
1877 to 1886	8	6	1937 to 1946	123	26
1887 to 1896	19	16			
1897 to 1906	21	15	Total	326	128
1907 to 1916	19	8			

Summer floods resulting from storms of high intensity are often violent. Runoff waters from areas depleted of their vegetation resulting in reduced infiltration capacities accumulate rapidly in well developed gully systems and rush down the steep mountain channels carrying large quantities of debris. Gullies and channels are left in an unstable condition to augment the seriousness of the next flood. Everything in the path of these torrents may be damaged. As the flood emerges from the canyon mouth large quantities of debris are deposited covering land, crops, and transportation improvements. In many instances irrigation diversion works are destroyed or buried

with debris, reservoirs fill with sediments, and canals are breached or blocked. In towns the floods cause damage to residential and business properties, merchandise, water supply and sewage systems, streets, bridges, and other public and private facilities. Around the fringe of the debris deposition zone, muddy water may fill basements, impair the quality of gardens and farm crops.

Future flood damages.—Flood damages will become more serious with continued deterioration of the uplands, and with more complete development and increased values within the flood plains. The greater frequency of floods since livestock grazing reached a peak in the early 1890's and the recent occurrence of floods from tributaries that previously had not flooded severely, also strongly suggests that the total damage from future floods will be greater. Some of the older diversion dams, irrigation canals, and debris basins have been weakened by past floods, greatly increasing future flood hazards. In addition to other damages, increased sedimentation will jeopardize agricultural productivity, cause greater irrigation canal maintenance costs, and result in loss of reservoir storage. However, estimates of future flood damages are based on flood frequencies developed from historical flood records.

The range resource is in jeopardy due to the rapid deterioration of the foothill winter ranges and headwater slopes. Other areas, which have been losing soil at relatively slow rates, are now reaching the critical stage where more serious and widespread erosion is imminent. Soil losses are now proceeding at a rate much in excess of soil formation.

It is estimated that future flood and sedimentation damages and range productivity losses will be $1,045,800 per year unless preventive measures are undertaken. Such losses will be equivalent to a tax of $107 annually on each family, in addition to the hardship and suffering that floods cause. The annual value of all types of damage in the basin is given in table 2.

TABLE 2.—*Estimated annual value of future flood damages and losses, Sevier Lake watershed, Utah*

Agricultural	$54,600
Residential	21,900
Municipal	11,000
Canal diversion works	10,400
Business and commercial	3,900
Railroads and utilities	1,700
Roads and highways	59,100
Reservoir sedimentation and water loss	143,500
Canal sedimentation	38,700
Flood control structures	4,800
Unrecorded and indirect damages	85,000
Recreation	236,600
Range productivity losses	374,600
Total damages and losses	1,045,800

Factors influencing floods.—Overgrazing is a primary factor in the increased frequency and recurrence of floods in the watershed. In many places overgrazing has reduced the plant cover and destroyed the litter. Many areas are now nearly barren. Livestock trampling has also compacted the surface soil, thereby further reducing its infiltration capacity. Much of the rain falling on such areas does not enter the soil but flows over the surface. As a result surface runoff is excessive and erosion is widespread. In many instances destructive

floods have resulted from only those small parts of a watershed which have been seriously overgrazed.

Roads without stabilized slopes and proper drainage concentrate runoff so as to erode fills and lower lying slopes. Fires destroy protective vegetation thereby contributing to excessive runoff and sedimentation.

Many mountain channels have become clogged with debris which has contributed to the formation of mud-rock flows. Irrigation water diverted from one watershed to another has degraded natural stream channels.

In addition to man-induced floods and erosion, there are limited areas of barren outcrops such as Cedar Breaks which contribute high surface runoff and immense amounts of sediment due to summer storms.

Downstream developments have intensified the seriousness of floods. Railroad and highway bridges in many instances have been built without adequate clearance for streams in flood. In other instances the capacities of downstream channels have been materially reduced by building encroachments and by debris.

CURRENT FLOOD CONTROL MEASURES

No large-scale concerted efforts toward development of flood control measures have been undertaken over the basin as a whole.

Locally, steps toward flood control have been taken by Federal and State agencies, local communities, and individuals.

The national forests were created about 50 years ago to place extensive areas of headwater lands under managed use in the effort to insure desirable conditions of stream flow and to maintain wild-land resources. Extensive modifications in grazing use have been made including elimination of trailing, reductions in stocking, changes in season of use, installation of an allotment system, and in the adoption of other related management practices. In addition, a fire-control system has been adopted, some contour terracing and reseeding of critical areas has been carried out, encouragement has been given to organized hunting and reduction of troublesome game herds, and other measures have been adopted.

In spite of this controlled management, there is a need for further improvement because (1) large areas of important watershed lands were seriously impaired before the need for management was recognized, (2) adequate programs of watershed management have been slow getting under way because of lack of appreciation of the problems and by lack of funds, and (3) lack of knowledge in some of the important phases of management.

Notwithstanding these obstacles, significant progress has been made. Concepts of certain basic principles of watershed management have been clarified by research and knowledge has been gained about the practical application of these principles through action programs.

The Forest Service in recent years has reseeded to perennial grasses about 18,000 acres of depleted range land on the Fishlake, Manti, and Dixie National Forests. In cooperation with local interests, the Forest Service constructed 14 debris dams on various creeks; however, most of the basins were filled with debris by floods shortly after con-

struction. A limited amount of contour trenching was done through cooperation with the Soil Conservation Service, Civilian Conservation Corps, and the Works Progress Administration on some of the headwater slopes. Overgrazing and lack of maintenance have reduced the original capacities and effectiveness of these measures although they saved some of the communities from severe damages in local floods.

On grazing districts the Bureau of Land Management has planned a soil and moisture conservation program which includes such measures as reseeding, adjustments in use, water development, fences, and minor structures for erosion control. Some work has been done but efforts have been restricted because of limited funds.

Two soil-conservation districts in the drainage basin, in cooperation with the Soil Conservation Service, have developed plans for flood control measures to be carried out in the communities within their boundaries, are assisting private landowners in applying land treatment measures and have undertaken some local protection work consisting mainly of channel and irrigation ditch improvements. The further installation of such projects now included in the district plans is limited by the inability of the districts to finance their construction. Four additional soil conservation districts have included in their planned program measures to protect agricultural land from flood and sediment damages.

The Soil Conservation Service with assistance from the Civilian Conservation Corps aided in the construction of contour furrows in certain headwater areas and certain channel improvements. Many of these improvements have now become clogged with debris and have deteriorated from lack of maintenance. The SCS is also furnishing technical services to soil conservation districts for applying land treatment measures.

Farm and ranch operators have installed additional conservation measures through the assistance provided by the agricultural conservation program of the Production and Marketing Administration. The Federal cost of the direct aids furnished by this program for such things as range reseeding, fences, water developments, erosion control dams, diversion ditches, etc., was about $69,523 in 1947 in Iron, Piute, Sanpete, Sevier, and Garfield Counties which comprise most of the watershed. However, these expenditures represent county totals not all of which were expended on flood source areas.

The Utah Agricultural Extension Service carries out activities related to flood control as a part of its regular work. This consists of educational assistance to farm and ranch groups and individuals by county and State extension service personnel. These activities promote improved land-use practices and emphasize the influence of proper practice upon flood and erosion control. Current expenditures by the Extension Service in the watershed amount to about $19,000 annually, of which approximately 40 percent are Federal funds.

The State of Utah in 1931 enacted a basic flood-control law which empowered the State land board to participate in the investigation and construction of flood-control projects. The State Flood Control Act of 1943 vested the State land board with extensive authority to inaugurate and participate in flood-control projects. As a result of these cooperative activities, several small debris dams have been built.

The State Fish and Game Commission has recognized the seriousness of the big-game problem and is cooperating with the Forest Service, the Fish and Wildlife Service of the Department of the Interior, and other agencies in efforts to reduce deer to the number that can be supported without damage to the watershed and to the deer herds themselves.

Little has been accomplished in achieving desirable range management in the mountain areas on private or State and county lands. Private interests have constructed debris catchment basins onManti,, Ephraim, Corn, and Red Creeks. Stream channels have been improved at the towns of Fairview, Mount Pleasant, and Salina.

The Congress has approved a flood-control project by the Corps of Engineers which will provide local flood protection in the vicinity of Redmond on the Sevier River (H. Doc. 614, 78th Cong., 2d sess.). The continued effectiveness of the authorized channel improvements in this program will depend to a considerable extent upon the volume of debris brought into the channel. No reduction in this volume will occur until preventive measures are taken on the watershed lands.

In virtually all instances, the success of past and current local flood-control measures has been limited by lack of adequate maintenance. This situation is especially serious because of the deteriorated condition of the contributing watershed. In some cases the protective measures have now so deteriorated that they are a threat to the very properties they presumably protect. The principal reason for inadequate maintenance is the financial inability of the local people to shoulder the burden.

Although the measures taken thus far have aided in reducing some local flood damages, they are inadequate and they do not provide protection to the damageable areas as a whole. The study of the areas revealed that adequate protection against damages from floods and sedimentation could be achieved only by the application of a number of interdependent measures thoroughly integrated into a widespread program for runoff retardation and soil-erosion prevention over the entire watershed.

RECOMMENDED REMEDIAL PROGRAM

A remedial program has been prepared for the watershed. In developing this program, consideration was given to several alternative methods. These included a land-treatment program alone, a structural program, and a combination of the two. The most effective program, which is also the most economic and self-perpetuating, is obtained by integrating the vegetative approach with certain complementary structural works.

The land-treatment phases would heal critical flood and silt source areas, stabilize soil, reduce surface runoff, prevent movement of soil material into the channels, and enhance the water resource. The complementary phase would afford immediate relief to affected people until the vegetative measures had taken full effect. They would also abate mud-flows originating in channels, reduce further channel cutting and reduce damages from areas of geologic erosion. Maintenance of the structural phases would be high initially, but would decrease as the vegetative program became increasingly effective.

The proposed program therefore not only unifies the physical and biological characteristics of the watershed but also meets the needs of the basin for immediate relief. The program will also provide many other widespread concomitant conservation benefits.

The costs shown are over and above all presently expended costs for comparable or related purposes. These costs, which include maintenance during an estimated 10-year installation period, are based on 1946 prices.

Reseeding and removal of undesirable plants now competing with and preventing successful reestablishment of more desirable plants, supplemented by reductions in range use by livestock and big game, will improve the cover on approximately 793,000 acres at a cost of approximately $3,288,000. On 124,000 acres of land now subject to severe erosion, such supplemental measures as contour trenches and furrows accompanied by artificial revegetation will help establish plant cover at approximately $3,487,000. Where site conditions are favorable the planting of trees will be considered as an alternative method of revegetating depleted areas. Gully erosion and stream bank cutting will be arrested by using some 181,000 brush stabilizers, 340 miles of plantings, and other similar and related stabilization measures at a cost of approximately $271,000. Installation and maintenance costs of these various restorative practices during the initial period will total about $7,046,000.

A number of supplemental measures are recommended. Range use by livestock and big game is to be reduced. On portions of the watershed temporary reductions will also be needed to permit natural recovery of vegetation, and to allow successful installation of other range rehabilitation and structural measures such as contour trenches and reseeding, channel works, and road bank stabilization. In some highly critical areas, use by livestock will have to be discontinued. Big game is to be managed in the interest of the soil and water resource. Destructive range rodents and insects are to be kept in check. To reduce further the possibility of denudation of watershed slopes, additional fire control equipment will be provided at a cost of approximately $6,000.

Related measures to aid in livestock distribution and management include approximately 400 water developments, 1,800 miles of fences, and 700 miles of truck trails. Purchase of water rights or rights to the use of water are estimated to cost about $1,000 annually. Road banks are to be stabilized and drainage improved. The total cost will be approximately $2,638,000 including maintenance during installation.

Approximately 316,000 acres of valley range lands will be reseeded concurrently at an estimated Federal cost of about $1,580,000 so as to provide forage for livestock temporarily removed, thus avoiding serious disruptions to the local economy. Reseeding of valley lands, public and private, under this program is to be restricted to those tracts which will be used by graziers who are affected by the reduced range use on the mountainous part of the watershed.

About 20 small structures at a cost of $108,000 are to check and stabilize headwater cutting in mountain gullies, too large for early control by vegetative means alone. Existing debris dams will be strengthened and 34 new debris basins with their appurtenant works and

spreading areas, and 11 floodwater diversions are proposed at an estimated cost of approximately $1,121,000 to catch debris already in transit, to make excess surface flows available for irrigation of range lands, and to increase ground water storage. About 365,000 linear feet of channel works including rectifications, necessary canal relocations, and related works, will cost approximately $1,064,000. These various complementary measures will reduce or control channel erosion, reduce opportunities for concentration of runoff, give protection from flood water and sedimentation hazards, prevent mud and other types of debris flows, decrease wastage of excess flows, and increase markedly the ground-water supply. They become effective immediately upon their construction. The cost of these complementary measures, including maintenance during installation, is $2,398,000.

A facilitating measure in the successful development of the program is the public acquisition of some 120,000 acres of privately owned watershed land in critical flood and silt source areas. The purchase cost is estimated at about $718,000. These lands would provide no direct financial return to the owner during the period they must be retired from use. In addition, considerable parts of these holdings have already so deteriorated that private owners cannot afford either to apply or to maintain properly the measures necessary to reduce flood and sediment damages originating on these lands. These critical areas, about 34,100 acres, consist of scattered private holdings within the present national forest boundaries. The remainder, about 84,900 acres, lie outside of but are adjacent to national forests whose boundaries should be extended to include them.

A consolidation of State land holdings in order to achieve better land management and administration of critical areas also appears highly desirable.

With the installation of the watershed improvement program the need will arise to measure its quantitative effects on erosion, runoff, stream flow, and channel stability, and to investigate the need for additional measures in the lower portion of the watershed in order to determine modifications needed for watershed protection. To accomplish this evaluation it may be necessary to install and operate stream gages, rain gages, snow courses, sediment sampling stations, erosion and runoff plots, sediment surveys of reservoirs and debris basins, surveys of channel erosion ranges, and other devices or methods.

TABLE 3.—*Estimated costs for installation of program, Sevier Lake watershed, Utah* [1]

Over-all treatment measures	Federal	Non-Federal	Total
Watershed restoration	$10,083,000	$1,181,000	$11,264,000
Structural works	2,065,000	333,000	2,398,000
Technical services and educational assistance	405,000		405,000
Total	12,553,000	1,514,000	14,067,000
Land acquisition	783,000		783,000
Grand total	13,336,000	1,514,000	14,850,000

[1] Includes cost of maintaining measures during installation period.

There is also need for manpower to provide adequate administration and management of the Federal lands to be improved under the recommended physical program. Technical services will be provided

to aid in planning and applying the program on non-Federal lands and to assist in integrating the measures to be applied to these lands with the over-all program. Before actual installation of the program, preliminary work will be necessary in order to insure orderly and systematic integration of the recommended program with existing and potential projects of the Bureau of Reclamation and other Federal and State agencies. Educational assistance will also be made available to inform private land operators of the program and its application and to assist in obtaining the cooperation of these operators in applying and maintaining the program measures. The cost of such additional manpower is $405,000 during the installation period.

The total installation cost of the entire recommended program, shown in table 3, is about $14,850,000 of which $13,336,000 is the Federal share.

Maintenance of program.—After the installation period, the lands will need to be managed to preserve their beneficial values. Some of the measures, such as fencing, will have to be kept in good condition to assure proper management and use. Because of the effectiveness of the vegetative program, structural maintenance will be small. The estimated annual cost of maintaining the recommended program after the installation period is $148,462 as shown in table 4.

TABLE 4.—*Estimated annual costs for maintenance of program, Sevier Lake watershed, Utah*

	Federal	Non-Federal	Total
Watershed treatment	$73,500	$24,600	$98,100
Technical service and assistance	50,362		50,362
Total	123,862	24,600	148,462

Participation in program.—The burden of initiation, completion, and maintenance of the various features of the recommended flood-control program will be borne in large measure by the Federal Government. It has been determined that assistance will be available from State and county governments, State soil-conservation districts, local communities, and from private owners and operators. In view of the Federal aids proposed, the widespread interest in the program, and the fact that the affected individuals are users of the public lands, it has been assumed that all of the affected landowners and operators will participate in its installation and maintenance.

Installation costs are allocated on the basis of public benefits to be derived from the measures. The Federal Government will pay the cost of all measures installed on federally owned land and land in the process of being acquired including installing new and modifying certain old debris basins, channel improvement and appurtenant works, and acquisition of critical lands for flood-control purposes. The Federal Government will pay the cost of all technical service and assistance up to 90 percent of all structural measures applied on non-Federal lands and up to 50 percent of all other measures applied on these lands. A portion of the cost of applying land-treatment measures to privately owned land will be provided in the form of direct aids.

The balance of the costs for measures on non-Federal lands will be borne by non-Federal interests.

Annual maintenance will be allocated as follows: The Federal Government will provide additional technical services on Federal land, additional technical assistance on non-Federal land, and will cooperate with the State of Utah in furnishing additional educational assistance. The Federal Government will also continue cooperative activities to insure integration and proper upkeep of the program especially on non-Federal lands and will afford the necessary maintenance to the various structures and measures on Federal lands. In addition, the Federal Government will assume responsibility for one-half the annual maintenance costs for fire protection on non-Federal lands and may participate in the maintenance of the structural works on these lands. Local agencies will provide the balance of maintenance required on these measures and complete maintenance for all other measures on lands in non-Federal ownership.

Local interests are to be required to furnish without cost to the United States all requisite rights-of-way and easements on non-Federal lands. Water rights or rights to the use of water will be acquired in accordance with existing State laws.

The Secretary of Agriculture and the head of any other Federal department concerned may construct such buildings and other improvements as are needed to carry out the measures included in the recommended program.

In carrying out the program, it is proposed to take full advantage of opportunities to utilize the services of the various conservation agencies, locally in the State as well as those in the United States Department of Agriculture and other Federal departments.

The program herein recommended includes the intensification, acceleration, or adaptation of certain activities under the current programs of Federal agencies in the watershed, and additional measures not now regularly carried out in such programs, all of which are necessary to complete a balanced runoff and waterflow retardation and erosion control program for the watershed. It is recommended that the Secretary of Agriculture be authorized to carry out all of this program except the part which is proposed for installation on land under the jurisdiction of a Federal agency other than the Department of Agriculture. It is further recommended that the head of such other Federal agency be authorized to carry out the part of the program which is proposed for installation on land under the jurisdiction of such agency. Although the current activities of Federal agencies in the watershed which are primarily related to the objectives of the Flood Control Act are not included in the program herein specifically recommended, the program is based on the continuation of such activities at least at their present level.

The authority of the Secretary of Agriculture or of the head of any other Federal agency concerned to prosecute the recommended program shall be supplemental to all other authority vested in him, and nothing in this report shall be construed to limit the exercise of powers heretofore or hereafter conferred on him by law to carry out any of the measures described herein or any other measures that are similar or related to the measures described herein.

It is believed that only through the measures and practices recommended for the watershed can widespread and beneficial waterflow retardation and soil-erosion prevention be achieved. However, the

Secretary of Agriculture and the head of any other Federal agency concerned may make such modifications or substitutions of the measures described herein as may be deemed advisable due to changed physical or economic conditions or improved techniques whenever he determines that such action will be in furtherance of the objectives of the recommended program.

PROGRAM BENEFITS

The combined effects of all the measures recommended will, in most instances, reduce the peak flows from summer storms below flood proportions. It is estimated that sedimentation rates will be reduced by about 55 percent on the average so that the useful life of irrigation works will be greatly prolonged. About a 60-percent reduction is expected in future average annual flood and sediment damages.

Other beneficial results will accrue from the program. The hazard of life within the flood plain will be lessened. The productivity of the range will be restored, and recreational values will be greatly enhanced. Fishing facilities will be increased and the big game herd stabilized. Irrigation will become possible on certain dry-farmed land once it is relieved of frequent flooding. Ground water supplies will be augmented. No appreciable reduction in the water supply is anticipated and the quality of the runoff waters will be improved.

Most of the benefits are based on the difference between expected future damages with and without a program. Others are obtained directly. The total benefits from the recommended program are about $1,181,000 annually of which those related to water control and its conservation alone are estimated at about $500,000 annually. Many other benefits ascribable to the program have not been evaluated. In addition, there are other benefits of a public nature which cannot be readily evaluated in monetary terms. A recapitulation of the estimated future annual benefits is shown in table 5.

TABLE 5.—*Estimated annual value of future benefits of program, Sevier Lake watershed, Utah*

Agricultural	$36,300
Residential	13,800
Municipal	9,200
Canal diversion works	7,100
Business and commercial	2,800
Railroads and utilities	900
Roads and highways	67,900
Reservoir sedimentation and water conservation	78,000
Canal sedimentation	18,900
Flood control structures	4,800
Increased cropland production	15,000
Unrecorded and indirect	55,600
Recreation, fishing, and hunting	217,800
Range conservation	[1] 652,900
Total annual benefits	1,181,000

[1] Benefits in excess of loss of income from range reductions or temporary nonuse.

Much of the relief and protection from damages will at first be largely dependent upon the structural phases of the program. Therefore, in the early stages, maintenance costs to preserve maximum effectiveness of the debris basins and channel works will be relatively

high. As the watershed remedial measures become increasingly operative, these costs will materially decrease and at later stages any loss in effective capacity of debris basins and channel works will be offset by compensatory reductions in runoff and debris movement due to the watershed-improvement measures. The integrated effect of all the measures will maintain the high degree of relief for which the program has been designed. The time period during which protection will rely largely on the structural measures, will depend on the condition of the tributary watershed. Some slopes above planned debris basins have now so badly deteriorated that it may require as much as 50 years to improve watershed conditions to that point where reliance need not be placed upon structures. In some areas the progress of vegetal controls will be greatly accelerated by installing such complementary measures as contour trenches, certain channel works, and other measures recommended, while in other areas natural vegetation will become effective within a very short time after some of the measures and controls are installed.

The program as outlined therefore relies for its full effectiveness upon a series of integrated dependent measures which combine to afford immediate as well as long-time relief from the flood and sediment damages in the basin.

COMPARISON OF BENEFITS AND COSTS OF PROGRAM

Benefits and costs.—The evaluation procedure used in developing the ratio of benefits to costs included the use of 1946 prices and a 2 percent interest rate. On this basis the total annual benefits have been estimated to be about $1,181,000. Total annual installation and maintenance costs have been estimated at about $445,000. The ratio of total benefits to total costs is thus about 2.6:1. As most of the flood and sediment areas are in Federal ownership and the economy of the region is so closely interwoven with the condition of these lands, the recommended program is also justified because of the public welfare and interests involved.

Additional economic appraisal.—An additional economic appraisal was approximated in order to evaluate the effect upon the benefit-cost ratio of fluctuations in price relationships and higher interest rates.

The standards used in this appraisal were: Indexes of 150 (1910–14=100) for prices received by farmers, 165 (1910–14=100) for prices paid by farmers, 300 (1913=100) for construction costs, 2½ percent interest to convert Federal and other public costs to an average annual cost and a 4 percent interest rate to convert private installation costs to an average annual cost and to evaluate land damage. Summarized below are the average annual benefits and costs as computed on these indexes:

Federal cost	$380, 000
Non-Federal cost	69, 000
Total cost	448, 900
Total benefit	892, 580

The ratio of the average annual benefits to the average annual costs on this basis is 1.9:1. If benefits, expected to be delayed in accrual, are discounted the resultant benefit-cost ratio is still favorable.

RECOMMENDATIONS

It is recommended that the foregoing program of runoff and waterflow retardation and soil-erosion prevention within the Sevier Lake watershed be installed at an estimated Federal cost of $13,336,000, and at an estimated cost to local interests of $1,514,000, or its equivalent, making an estimated total cost of $14,850,000 for the installation of the recommended program.

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